

Lesson #1 Leaf Exploration

What's Happening to our Plants?

Previous Lesson: Where we've been... According to NGSS standards in 2nd and 3rd grade students have begun learning about interdependent relationships in ecosystems, growth and development of organisms, and social interactions between organisms. They will have some background on the fact that organisms and plants in the garden will interact and a minimal understanding that plants and animals have features that help them in their development.

This Lesson: What we are doing now... This lesson's goal is to introduce the students to the phenomenon "What is damaging our plants". The students will be entering the garden looking at the different types of damage to the plants in the garden. In the garden they should make observations on the different types of damage on different plants. There will then be a 15-20 minute teacher explanation surrounding student observations, various types of herbivory damage, and the type of herbivory damage most prevalent in this garden. Integrated into this explanation phase will be a KWL activity to elicit student knowledge and questions.

Lesson Question	Phenomenon	Lesson PEs	What we figure out (CCC, SEPs, New Questions & Next Steps)
<p>What is causing damage to our plants?</p> <p>15 min. Exemplar plant</p> <p>15-20 min. Garden exploration</p> <p>15-20 min. Damage explanation lesson</p>	<p>Phenomenon: What is damaging the plants in the garden?</p> <p>Students will learn how to identify damage of different varieties in order to address the question of what is happening to the plants in their garden.</p>	<p>PE 4-LS1-1 Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.</p> <p>Sub PE #1: Analyze: (Discriminate) between signs of damaged versus undamaged plants.</p> <p>SEP #1: Engaging in Argument from Evidence</p> <p>SEP #2: Ask Questions: (Wondering) about how the damage occurred to the plant</p>	<p>Through the hands-on leaf exploration, students will observe different amounts of herbivory in different plants and note that some plants have much less damage than others - tomato plants vs. blackberry. Students will begin to ask the questions: What is causing this damage? How much damage is there? Why do some plants not have as much damage as others? (CCC #1 Cause and Effect)</p> <p>Next Steps: Investigate how we can quantify the amount of damage done to plants/leaves</p>

		structures: potentially wondering why certain plants have more/less damage.	
Next Lesson: Where we're going... Now that students have a baseline understanding of plant damage and different possible reasons for the damage, they will work on techniques for measuring and assessing damage more systematically for comparison.			

Getting ready: Materials Preparation	
<p>Materials for each class:</p> <ul style="list-style-type: none">- Garden with plants being actively damaged by herbivorous insects. This may involve stopping pesticide treatments in a given area 2-3 weeks before the lesson to allow herbivorous insects time to create damage.- Recommended plant species to plant for easy damage- varieties of tomatoes, lettuce, blackberries, radishes, beets. Non-vegetable plants- Roses, foxglove, bittersweet, hyacinths	<p>Preparation of materials (~15 min reading; 10 min. to pot an exemplar plant):</p> <ul style="list-style-type: none">- For examples of common herbivory damage, go to https://www.fix.com/blog/common-garden-pests-and-how-to-get-rid-of-them/, and for common plant defense strategies appropriate for the lesson, visit: https://en.wikipedia.org/wiki/Plant_defense_against_herbivory#Mechanical_defenses (start with “Mechanical defenses” and go until the section on “Costs and benefits”- Note 1: Have an exemplar plant in a pot the day you start the lesson. Say that you found it outside that morning, and that you worry for the fate of the other plants in the garden. Empower the students with hand lenses and observation sheets (Activity Sheet 1) to seek out the infestation.
<p>Materials for each student: Hand lens (Optional), Activity Sheet 1, KWL worksheet</p>	
<p>Safety: None</p>	

Getting Ready: Teacher preparation		
<p>Student background knowledge:</p> <ul style="list-style-type: none">- Aware of independent relationships between organisms in an ecosystem- Aware that plants use sunlight and water to survive and grow- Been exposed to life cycles of organisms- birth, juvenile development, adult development, death <p>Teacher background knowledge:</p> <ul style="list-style-type: none">- Plants use macro structures to defend against insect herbivory- Different plant varieties will employ different defensive means and will meet different successes and compromises.	<p>Alternative student conceptions:</p> <p>None</p>	<p>Linking our understanding to scientific terminology:</p> <ul style="list-style-type: none">- Observe and Wonder- Herbivore/ Herbivory- Damage- Defenses

Learning Plan: Leaf Exploration <i>What's Happening to our Plants?</i>	Teacher support and notes
<p>1. (15 min) Show the class the potted exemplar plant and share with the class that you found it outside that morning and that you are worried about the fate of the other garden plants.</p> <p>Pass around the plant to allow the students to begin making observations about herbivory damage. Guide your students into investigation by asking questions like:</p> <ul style="list-style-type: none">→ What do think happened to this plant?→ Are others going to experience the same thing?→ Should we go out into the garden and check? <p>Students will likely be engaged and eager to explore more^A.</p> <p>2. (15-20 min) Allow students to begin investigating “What’s happening to our plants?” through garden observations. Before going out into the garden, remind your students that scientists keep track of their observations for use later on. Pass out Activity Sheet 1 and ask students to look for three examples of damage. Their observations should be recorded in both drawings and 1-2 summarizing sentences. Pass out hand lenses as an additional scientific tool^B (optional).</p> <p>To help guide observations^C, ask:</p> <ul style="list-style-type: none">→ How do you know if a plant has damage?→ Are there different types of damage?→ Is there a lot or a little damage?→ Is there more or less damage on this leaf than the previous leaf you observed?→ Are there different types of damage on different plants?	<p>Alternative: Make the introduction of the exemplar plant into its own lesson.</p> <p>A. Strategies for Engaging Students Use the exemplar plant, prompts, and promise of going outdoors to engage students. Although you will be prompting and guiding students, they should be generating a lot of their own ideas throughout this lesson.</p> <p>B. Scientific Tools Although hand lenses and other aids are great aids, don’t forget that careful observations by the naked eye can be the best scientific tool there is! Support your students as practicing scientists by allowing them to have agency in their own investigations.</p> <p>C. Strategies for Effective Observation Creating meaningful observations can be difficult, use these prompts to help students begin quantifying and comparing/contrasting their observations.</p>

→ If so, what type have you seen the most of?

Listen for student responses, such as:

→ *I know there's damage because there's holes in these leaves. This plant (tomato) has a lot of damage but that plant over there (blackberry) didn't have much. I am mostly seeing leaves with lots of holes in them, but I did see a couple with a bunch of weird white lines on them. I don't want our plants to die! What is causing all this damage?*

Students will carry their observations and questions into the next activity, where they will get the chance discuss and write what they think they know and what they wonder.

Note: Be on the lookout for responses from students who have prior knowledge about the topic of herbivory^D.

→ *We have plants in my garden at home that have holes in them also. My mom says this is because of bad bugs that like to eat everything!*

Be prepared to encourage these students to investigate further. Ask:

→ What types of bugs do you think they are?

→ Do you see any in this garden?

→ Do you think other things can cause damage as well?

3. (15-20 min) After gathering the students back into the classroom, have them begin writing down some things that they think they know in the first column of a KWL worksheet^E.

Afterwards, facilitate a discussion of what they observed and write some key

D. Addressing Prior Knowledge

Some students may already know something about herbivory. Although they may think they already know the answer to “What’s happening to our plants?”, there is always further scientific discoveries to be made. Prompt them to investigate further. Additionally, don’t be afraid to go ahead and discuss the topic of herbivory in greater detail if you think your class is ready for it.

E. KWL Worksheet

The Know and Wonder sections of the Know, Wonder, Learn teaching strategy will be useful in this lesson to further determine the amount and type of student prior knowledge, as well as allow student questions to help guide further investigations. The Know section can be used as a tool in formative assessment. The Learn section will be more useful in a later lesson.

observations up on the board for everyone to see. As students share observations of different types of damage, take this opportunity to integrate further explanation about these as well.

For example, as students share that some plants have holes and others have unusual white lines, introduce them to the terms skeletonized and mining.



If any prior knowledge about insect damage on plants comes in discussion, you can also take this opportunity to introduce and explain the term herbivory^D. Otherwise this term and concept will be explored further in subsequent lessons.

Next, you will want your class to determine what the most prevalent type of damage in your garden is. You will see in the next lesson how this will help with consistency and standardization. If one type isn't an obvious winner, take the time to tally up each student's observations as a class^F.

To wrap up this lesson, have students write down a couple questions about what they wonder in the second column of their KWL worksheet. Then ask students to share their some of their questions, which may include:

- Why is this happening to our plants?
- How much damage is occurring?
- Why did I see differences between some plants?

F. Math Extension

You could easily transform your “tallying up” of damage types into a math extension student activity. For example, after tallying up the damage types themselves, you could have them make a bar graph or alternatively have them find proportions or percentages and make a pie chart.

G. Strategies for Building Consensus

Help build consensus about where this investigation will go by highlighting these sorts of questions. You could highlight them by writing them on the board for everyone to see. Another way to center discussion around these questions is to ask students directly other supporting questions, such as, “Do you want to know if our plants will survive this damage, did you see a lot of damage when you were outside, what plants did you

Their responses will likely include an array of other questions as well, but highlight the questions along these lines in order to guide the following investigations^G.

look at and what kind of damage did you find on them?"

Lesson 1- Student Activity Sheet 1: **What's Happening to our Plants?**

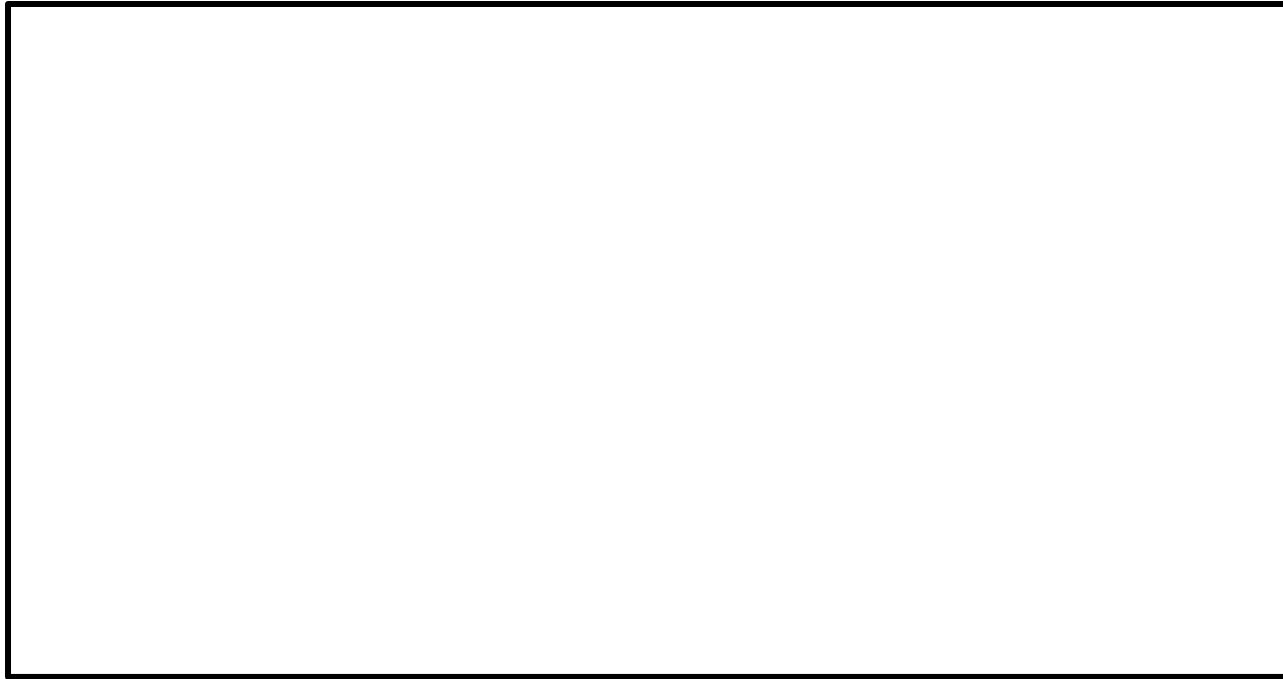
Name: _____

Date: _____

When you find a damaged plant, draw what you observe in the box. Where did you find this damage on the plant?



What do you notice?



What do you notice?
